Child Spanish Lexicon and Morphosyntax as a Predictor of Inhibition

Research Thesis

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Abstract

Recent studies of the relationship between lexical development and inhibition suggest that as the size of the lexicon increases, so does inhibitory ability. The relationship between grammar and inhibition seems somewhat more controversial. Dispaldro et al. (2013) finds a relationship between inhibition and grammar, but not in TD children. Bishop & Norbury (2005) and Ladányi & Lukács (2016) do not find significant correlations between language and inhibition. However, Kaushanskaya et al. (2017) does find an association between a composite syntax measure and inhibition, but not between inhibition and a composite lexical measure. This work distinguishing the relationships between inhibition and lexicon vs. grammar have all been carried out in English, which has relatively impoverished inflectional morphology. Because the relationships considered in the literature are hypothetically not language-particular to English, but rather claims about cognition in general, we would expect to find that they also hold in other languages, including languages with rich morphology, such as monolingual Spanish. These considerations lead us to ask: are expressive and receptive measures of lexicon associative of typically-developing monolingual child Spanish-speakers' inhibitory ability, and are expressive and receptive measures of morphosyntax associative of typically-developing monolingual child Spanish-speakers' inhibitory ability? We test a sample of 82 monolingual, typically-developing Spanish-speaking children in Mexico City, with 5 lexical measures, and 4 morphosyntax measures, as well as the Flanker Task of inhibition. Results showed that all lexical and morphosyntactic variables correlated with Flanker ($p < .01$), with the exception of NDW, calculated on the spontaneous production sample. Implications of these results are discussed.

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Introduction

Executive function can be defined as the way in which behavior is controlled cognitively. Through the use of their executive function, an individual can select and monitor their behaviors that facilitate a specific action or actions to achieve a certain goal. Miyake et al. (2000) writes that there are three important sub-components of executive function, which are inhibition, attention (shifting), and working memory (updating). These abilities are mildly correlated with one another, but also account for unique variance in complex executive function tasks that use more than one component of executive ability (Miyake et al. 2000). The component that is most important to our study is the idea of inhibition, and how inhibition is related to language development. Inhibition is one's ability to control impulses or automatic responses through the use of attention and reasoning.

In considering the literature on executive function and language development, we find a prominent stream of work discussing what is referred to as the "bilingual advantage", first noted in Peal and Lambert (1962). Though this project will not address this connection between greater inhibitory abilities in bilingual children and their language abilities, this literature nonetheless contains some of the most thorough discussions of the language-executive function connection and will therefore be reviewed.

In addition to the discussion of executive function and language development in bilingual children, there is also a significant literature discussing the connection between language development and executive function in atypical populations. This literature includes some of the

best work clarifying the causal relationship between inhibition, in particular, and language and will therefore also be discussed.

In the end, our goal is to understand the connection between not only lexical development and inhibition, which seems to be the primary relationship discussed in the literature, but also the relationship between morphosyntax and inhibition. The literature also appears to contain many studies of executive function and either very specific measures of language (e.g. lexical decision tasks) or very gross measures of language (e.g. composite language scores from standardized tests such as the CELF, TOLD, etc.). Our approach will be to take a single, widely-used measure of inhibition, the Flanker Test (Eriksen & Eriksen 1974), and to then compare these results with five distinct measures of lexicon and with 4 distinct measures of morphosyntax, in a monolingual Spanish-speaking population in Mexico. Our hope is that in this way, we can learn something about the relationship between inhibition and two distinct domains of language.

Miyake et. al (2000) - Simple and Complex Executive Function Tasks

In a study conducted by Miyake et al. (2000), they looked at shifting, updating, and inhibition (three executive functions) and examined them at the level of latent variables rather than individually. By studying them as latent variables, Miyake et al. were able to examine "what is shared among the multiple exemplar tasks for each executive function" (Miyake et al., 2000), as well as minimize any issue of task impurity. The reason why reducing any problem of task impurity within the study is important is to control variance due to task demands that vary across executive function measures. Miyake et al. explain how previous studies have made correlations and regressions to see how well the participants' performance was either grouped or separated into certain tasks, including the Wisconsin Card Sort Task (attention), Tower of Hanoi (inhibition), Operation Span (working memory). The results from these studies, as Miyake et al.

describe, have typically showed a low correlation among the different executive function abilities, which is not usually significant. Additionally, Miyake et al. describes how factor analysis within these studies has typically separated the results and attributed them to multiple underlying factors.

As a result, Miyake et al. created a study that aimed to see if models with 1, 2, or 3 latent variables fit better with executive function measures, and to see if latent variables extracted from the first analysis can predict participants' performance on a complex task that requires – in theory – multiple aspects of executive function. To represent each of their different executive functions (shifting, updating, and inhibition), Miyake et al. used three different tasks to accompany each executive function, totaling nine tasks for their 137 participants. The tasks used in Miyake et al's study for shifting were Plus-Minus, Number-Letter, Local-Global. Updating used Keep Track, Tone Monitoring, and Lettering. For inhibition, Miyake et al. used Anti-saccades, Stroop, and Stop-Signal. In addition to these tasks, Miyake et al. included five complex executive tasks as the outcome measures, predicted by the latent variables, which were the Wisconsin Card Sorting Test, Tower of Hanoi, Random Number Generation, and Operation Span Task. Results from Miyake et al. show that each latent executive function variable is correlated. From this, Miyake et al. conclude that attention, working memory, and inhibition are separate, but related. Although the tasks are independent, they are correlated, and give us an idea of more complex executive function tasks.

Miyake et al. is foundational in the modern study of executive function because it shows that each of three components can produce variance that loads on single latent variables, using factor analysis. It then shows that each of these latent variable – now independent of specific tasks – can predict components of the variance in complex executive function tasks in a

structural equation model. While the latent variable executive function components are somewhat correlated with one another, they are also independent and capable of significantly predicting unique variance in tasks that use more than one component of executive ability.

In other previous literature, we know that executive function and language development have been studied, specifically with children on the autism spectrum and children diagnosed with attention deficit hyperactive disorder. These non-typically-developing children are known to have lower executive function (inhibitory) abilities than do typically-developing children (Ozonoff, Pennington & Rogers 1991; Ozonoff & Jensen 1999). Executive functioning deals with emotion regulation and controlling impulses, which is said to be lacking in children on the autism spectrum and with children who have attention deficit hyperactive disorder. Furthermore, typically-developing bilingual children are argued to have greater inhibitory ability than do monolingual children (Martin-Rhee & Bialystok 2008: Bialystok & Craik 2010; Kroll et al. 2012). Thus, inhibitory executive function ability and language development seem related, but what parts of language are related?

Organization of the Thesis

In what follows we will first review the substantial literature looking at what Miyake et al. might refer to as "pure" measures of inhibition, paired with different measures of language. Then we will turn to a number of studies of other aspects of executive function and language development. Finally, we will consider the claim by Baayen et al. (2002) that inflectional morphology can be stored not only in a stem + affix manner, but also that stem + affix combinations may be stored as complete or wholistic units. This hypothesis is consistent with not only increasing uninflected lexical items predicting greater inhibition, but also with increasing

(apparently) inflected lexical items predicting greater inhibition. First, we turn to an overview of studies that consider the link between inhibition and language development.

Inhibitory Control

Martin-Rhee & Bialystok (2008)

In the study conducted by Martin-Rhee and Bialystok (2008), they specified the type and degree in which bilingual children show their advantage of being able to do exceptionally well in specific tasks that require inhibitory control to ignore deceptive perceptual cues. Through Study 1, where Martin-Rhee and Bialystok used the Simon task to study inhibiting attention, and Study 2, where Martin-Rhee and Bialystok used the Stroop task to study inhibiting habitual response, they found that bilinguals were more advance in their ability to inhibit attention, but that bilinguals and monolinguals were equal when it came to inhibiting a habitual response. The bilingual children used in this experiment were French, Chinese, Hebrew, Spanish, and Russian, which the experimenters concluded made no difference in their results. Through Martin-Rhee and Bialystok's experiment, they were able to provide results that were consistent with previous research that claims that bilinguals are more advanced than monolinguals in their ability to control attention. Inhibiting an incorrect response is vital to controlling attention. Having in-depth knowledge of a language, or in this case, languages, is crucial to developing stronger inhibitory skills, as we will see in our study.

Bialystok and Craik (2010)

In their 2010 study conducted, Bialystok and Craik investigated the way in which bilingualism affects cognitive and linguistic performance across the life span. Bialystok and Craik acknowledge cognitive processes are heavily dependent on linguistic abilities, but question

if the number of languages an individual speaks shapes the brain. As a result, they address the question: how does bilingualism affect cognitive and linguistic processes in general? Through several paradigms previously studied, including the proactive interference (PI) task, verbal-fluency test, Stroop task, and Simon task, experimenters tested participants who are healthy and free from cognitive impairments. But Bialystok and Craik questioned aging and how challenges like dementia are extremely common and tested to see if bilingualism can also prove to be beneficial cognitively in comparison to monolinguals who have dementia. They compared the age of onset of symptoms in 91 monolingual and 93 bilingual patients who had been diagnosed with dementia. With all else being equal, the age of dementia onset for the bilinguals was 4 years later than it was for the monolinguals—a highly significant difference (Bialystok and Craik, 2010). Based on this research, Bialystok and Craik were able to conclude that experience of speaking two languages on a regular basis has broad implications for cognitive ability, enhancing executive-control functions across the life span (Bialystok and Craik, 2010). The only negative consequences of bilingualism that they found was on verbal knowledge and skill, however, this was outweighed by the evidence that states just how much executive function is improved in bilingual speakers. Executive function plays a role in linguistic ability, which as we will see in our study, is an important piece to strong inhibition.

Blumenfeld and Marian (2011)

Evidence suggests that bilinguals outperform monolinguals in terms of inhibition. In Blumenfeld and Marian's study conducted in 2011, they looked at how processing linguistic ambiguity during auditory comprehension may be associated with inhibitory control. They hypothesize that bilingual experience acts on inhibition mechanisms used during language processing, resulting in bilingual and monolingual performance being compared (Blumenfeld

and Marian, 2011). They took thirty English-native monolingual speakers and thirty English-native bilingual speakers, who also spoke Spanish. The way in which bilinguals were selected was by ensuring that bilinguals had extensive Spanish experience, as well as currently have Spanish exposure. Blumenfeld and Marian administered to them the Language Experience and Proficiency Questionnaire (LEAP-Q) and reported that monolinguals and bilinguals did not differ in terms of English proficiency across comprehension, reading, and speaking. Through trials of Word Recognition/Eye Tracking, as well as Priming Probe trials, the experimenters were able to index activation of competitor words and control words during recognition, and index inhibition of preceding words relative to control words (Blumenfeld and Marian, 2011). Upon the completion of 25 practice trials, Blumenfeld and Marian started the procedure with participants by having them listen to auditory stimuli and viewing pictures in four quadrants of a visual display. Participants then identified the quadrant containing the target they heard by pressing one of four keys (Blumenfeld and Marian, 2011). Immediately following each of the Word Recognition trials, participants were presented with a Priming Probe trial. Participants were then administered the nonlinguistic Stroop task, followed by multiple linguistic related tests (Blumenfeld and Marian, 2011). The results from these tasks support the prediction that if bilingual experience modulated cognitive control mechanisms associated with language processing, then monolingual and bilingual groups would differ in their use of inhibition to resolve competition between similar-sounding words (Blumenfeld and Marian, 2011). They conclude that mechanisms working during language comprehension are likely to be influenced by bilingual language experience (Blumenfeld and Marian, 2011). One of these mechanisms working during language comprehension is inhibition, which is important for our study.

Blomquist and McMurray (2017)

In a study conducted by Christina Blomquist and Bob McMurray, they looked at how we access a target word in our mental lexicon by using an eye-tracking paradigm in school-aged children (Blomquist & McMurray, 2017). While there is evidence that adults display this lexical competition in word recognition with inhibitory connections between words, Blomquist and McMurray used their study to investigate the possible role of inhibition in lexical competition during spoken word recognition in children (Blomquist & McMurray, 2017). They also sought to know if this inhibition may serve as a mechanism for change in the dynamics of lexical competition across development (Blomquist & McMurray, 2017). Their method consisted of 46 child participants in two different age groups: one a 7-8-year-old age group and the other a 12-13-year-old age group (Blomquist & McMurray, 2017). The eye-tracking in the Visual World Paradigm was used to investigate lexical inhibition. For each trial, each participant saw 4 pictures on a computer screen, heard a word, and then selected the picture referent of that word while eye-movements were monitored (Blomquist & McMurray, 2017). Following the VWP task, participants conducted the spatial Stroop task to measure inhibition, as well as other subtests (Blomquist & McMurray, 2017). From their results, it appears that the older children are not able to resolve the lexical interference caused by temporary activation of a competitor as well as the younger children, as efficiency in lexical processing develops in the school-age years, and this development may be linked to changes in underlying competition processes (Blomquist & McMurray, 2017). They realized from their study that there are clear age-related differences in response to processes in which word recognition occurs (Blomquist & McMurray, 2017). Blomquist and McMurray conclude that their study showed no results of a significant relationship between inter-lexical inhibition and vocabulary (Blomquist & McMurray, 2017).

But perhaps, this study leads us to believe there is something more present; something semantically related rather than phonologically related.

Gangopadhyay et al. (2018)

There has been much research around exactly at which point in a child's life can a child resist distractors or irrelevant information during lexical processing. This inhibition has been studied in children and adults that are both monolingual and bilingual to see exactly how lexical processing is affected by inhibition and when exactly we become able to separate these distractors. In the study of Gangopadhyay et al. (2018), they tested for this association between lexical processing and inhibition in both English-speaking monolingual children and simultaneous Spanish-English bilingual children at two different times a year apart. Gangopadhyay et al. used an English lexical decision task and two inhibitory tasks, one being the Flanker task and the other being the Go/No Go task. This study shows a cross-sectional sample of children that inhibitory control was a significant predictor of how well a child did in the lexical decision task that the experimenters used in their research. Yet through their longitudinal experiments, Gangopadhyay et al. discovered that later inhibition was predicted by early lexical performance, but later lexical performance was not predicted by early inhibition skills. Regardless of whether the children were monolingual or bilingual, these discoveries held true. Based upon these results, Gangopadhyay et al. speculate that bilingual children show a stronger relationship between lexicon and inhibition.

Larson et al. (2020)

In the study developed by Larson et al. (2020), inhibition, morphological understanding, and receptive vocabulary were tested in children with specific language impairment (SLI), as

well as in children who were typically-developing (TD). Larson et al. worked with a sample of children who were both TD and others who had SLI at two time points one year apart (Year 1, Year 2), and used the Flanker Task to determine the resistance of simultaneous interference. Their results showed that their does exist a relationship between language and inhibition, but between the TD and SLI children, their morphological comprehension differed. Based upon these results, Larson et al. were able to conclude that diminished inhibition skills in SLI children might be the reason for their weakened morphosyntactic skills.

Other Aspects of Executive Function and Language

In addition to the previous studies that addressed inhibition, specifically, and language, there are other studies that look at either more complex executive function tasks or at a range of measures of executive function abilities and language.

Minai et al (2012)

The research conducted by Minai et al. in 2012 look deeper into the understanding of universal quantification in children. They propose this idea of symmetrical response (SR) that occurs in children in which an atypical semantic interpretation occurs involving a quantifier. They illustrate this in their article where they cite the Philip, 1995 findings where Philip showed that if children are explicitly asked "Is every boy riding an elephant?" followed by a picture showing some boys each riding an elephant and an extra elephant nobody is riding, 3-5-year-old children will respond no and use the extra elephant as their reasoning, even though the extra elephant does not falsify the fact that every boy is riding an elephant (Philip, 1995). Thus, Minai et al. reason that children reject these sentences by reasoning that the falsifier is the presence of the extra object which ruins the symmetrical one-to-one relation between boys and elephants in

the picture, which is another way of showing the SR at work in children (Minai et al., 2012). Minai et al. hypothesize that the extra object, though salient, is irrelevant information that hinders children's successful universal quantification and attribute this to children's cognitive development and is reflective of their still-developing theory of mind (ToM) (Minai et al., 2012). Based on this hypothesis and previous research, Minai et al. took four and five-year old Japanese acquiring children in Japan and examined the link between the development of cognitive control and their interpretation of the universal quantifier by using the dimensional change card sort (DCCS) task. The DCCS is a complex executive function task that measures children's ability to switch perspectives between two competing dimensions that both serve as different standards for card sorting (Minai et al., 2012). They also used the truth value judgement task (TVJ) to examine how often children look at various parts of a picture, which will be useful in determining what children are paying attention to when they reach the SR. Their results showed the link between children's successful universal quantification with respect to extra-object pictures and a shallower decrease in card sorting accuracy over the rule-switch in the DCCS (Minai et al., 2012). These present findings suggest that children's non-adult-like universal quantification with respect to extra-object pictures is considerably affected by their extralinguistic difficulty in switching perspectives using successful cognitive control in picture recognition (Minai et al, 2012). They conclude that cognitive control is a factor that influences semantic processing involving universal quantification, and in children aged four to five, this is still developing (Minai et al., 2012).

Dispaldro et al. (2013)

Infants must be able to detect temporal cues that are in noisy acoustic spectra of ongoing speech by efficient attentional engagement, according to Dispaldro et al. Additionally, Dispaldro

et al. claim that obstruction to the temporal sampling of stimuli could be responsible for language deficits that are seen in children with specific language impairments. In a 2013 study conducted by Dispaldro et al., they tested the efficiency of visual engagement in children by measuring their attentional masking. Using 44 Italian children (22 children with SLI), Dispaldro et al had measures of expressive language and receptive language for both lexicon and grammar present in the study. After using TVL (Test do Valutazione del Linguaggio), P-IQ (Performance IQ), BNT (Italian version of the Boston Naming Test), an expressive morphosyntax task, PPVT, TCGB (Test di Comprensione Grammaticale per Bambini), Dispaldro et al. results showed that children with SLI had a deeper attentional masking (AM) than typically developing children, as well as showed that children with SLI have an abnormally slower temporal window, affecting their ability to of perceptualizing objects necessary to understand constant information flow. They concluded that a sluggish engagement of visual temporal attention could be found in children with with SLI. Additionally, Dispaldro et al. concluded that individual differences in temporal engagement of attention predicted the grammatical performance with SLI participants. Dispaldro et al. hypothesize that this slower engagement contributes to inefficient processing of quick linguistic objects in the input. Dispaldro et al. also hypothesize that the neural basis of temporal engagement deficits in children with SLI could be a mild right fronto-parietal dysfunction.

The information found within Dispaldro et al. (2013) is significant in our study due to its complex connection to executive function. With the attentional masking aspect of this study, we see that visual working memory is at work, and there is a significant correlation between AM and lexicon. Dispaldro et al. (2013) show this unique variance between attentional masking, age, performance IQ & IE through a multiple regression plot. While attentional masking is not an inhibition task, nor is it associative of pronoun comprehension or lexical comprehension in

typically developing children when age is included in the multiple regression, Dispaldro et al. (2013) study does show that attentional masking correlates with lexicon, which is important in understanding the way in which inhibitory skills develop in bilingual children.

Kaushanskaya et al. (2017)

In a 2017 study conducted by Kaushanskaya et al, research was done regarding the topic of nonverbal executive function skills in school aged children in order to better understand the relationship between nonverbal executive function skills and language performance within this age group (Kaushanskaya et al, 2017). Using seventy-one typically developing children, ages eight through eleven, they measured three executive function components, which were inhibition, updating, and task-shifting, through two nonverbal tasks (Kaushanskaya et al, 2017). Additionally, they aimed to use a latent variables approach when measuring nonverbal executive function performance in children to extract latent scores representing each executive function construct (Kaushanskaya et al, 2017). Along with this, subjects were also given common standardized language measures (Kaushanskaya et al, 2017). Their results indicated that nonverbal updating was associated with the receptive language index on the Clinical Evaluation of Language Fundamentals-Fourth Edition (CELF-4) and nonverbal inhibition was found to be predictive of children's syntactic abilities (Kaushanskaya et al, 2017). In the study, syntactic abilities are measured by a morphosyntactic grammaticality judgment task, from the TOLD I:4, and from the Concepts and Following Directions subtest of the CELF-4. Thus at least morphosyntax, in the form of the grammaticality judgment task, appears to be associated with inhibition. Kaushanskaya et al show through this research that language performance may be related to domain-general executive function (Kaushanskaya et al, 2017).

Patra et al. (2018)

There appears to be much research and many opinions as to whether bilinguals do better, worse, or equally as good as monolinguals do with verbal fluency. The reason verbal fluency is significant in looking at inhibition is it is telling of executive function, which controls an individual's cognitive inhibition. In the study ran by Patra et al. (2018), they used quite a few measures to determine fluency in both English monolinguals and Bengali-English bilinguals. Through their collection of semantic and letter fluency data from both groups, Patra et al. were able to determine that bilinguals show differences in linguistic and executive control in the fluency task. Their results showed that bilinguals perform better than monolinguals do on the verbal fluency task, which is said to be more telling of executive control.

Morphosyntax Can be Stored in the Lexicon

Baayen et al. (2002)

In Baayen et al. (2002), the issue of the balance of storage and computation for regularly inflected words in Dutch in language comprehension was addressed. One of the arguments that is discussed is one used by Pinker and Clahsen concerning the occurrence of frequency effects for complex words, which they argue is restricted to irregular complex words, as mentioned by Baayen et al. (2002). The two token frequency effects, as described in Baayen et al. (2002), is the Surface Frequency Effect and the Base Frequency Effect. The Surface Frequency Effect describes the frequency of complex words, e.g. *cant-a-mos*, Though the word *cantamos* has three morphemes, the Surface Frequency Effect assumes that the word is stored as a whole. In contrast the Base Frequency Effect is the product of all of the different variants of the root *canta* being accessed and is taken to be predictive of reaction times that involve accessing this root and its variants (i.e. the lexeme of *canta*).

The research conducted by Baayen et al. (2002) shows very reliable results for Surface Frequency Effects for regular inflected words. In the four experiments conducted by Baayen et al. (2002), they presented an outline of the rules of the plural suffixes in the Dutch language. After applying these rules, they took their paid participants, who were undergraduates at Nijmegen University, and had them do a paper and pencil task, and computer task. These experiments conducted by Baayen et al. (2002) allowed them to create 80 pseudowords (none of which violated any Dutch phonotactic rules) that tested their rhythmic principle, as well as their response times to stimuli showing perfect participles, past plural inflections, and present participles in Dutch. Their results showed that not only fully regular noun plurals are stored, but also fully regular inflected verbs which have no rival "suppletive" affix in the language reveal substantial effects of storage. Baayen et al. (2002) were also able to show through this data the irrelevance of the default status of affixes. According to Baayen et al. (2002), this supports the notion that a wide range of linguistic and cognitive factors (i.e. frequency of occurrence, computational complexity, relative costs of storage and computation in mental lexicon) determines the balance of storage and computation. The importance of this study is that it suggests that what appear to be multi-morpheme forms in child language – the kind that show up on standardized tests of morphosyntax – may be stored as whole units in the lexicon. Given what we have seen with increasing lexical scores predicting increasing inhibition scores, Baayen et al.'s results make it seem plausible that we may also find this type of predictive relationship between morphosyntactic development and inhibition.

Global Summary

To summarize, language development appears to drive inhibition. When looking at inhibition ability in children, it would make sense that bilingual children have stronger inhibition than monolingual children do, as bilingual children have a more expansive knowledge of language. Both languages are simultaneously active when a bilingual is using one of them (e.g., Grainger and Beauvillain, 1987; Brysbaert, 1998; Kroll and Dijkstra, 2002). The experience of controlling attention between these two languages is a source of practice that boosts those control processes and makes them available for other tasks, such as the perceptual decision tasks used in these experiments. (Martin-Rhee & Bialystok, 2008, pp. 91-92). When looking at executive function, a child's executive function ability is correlated to cognitive abilities like inhibition, which is important to our study. Other measures like fluency and morphosyntax also give us an idea of the cognitive abilities of a child, allowing us to better understand their lexical capabilities, which is important for us in evaluating their inhibition. As we have just seen, it is also possible that morphosyntactic variants of the roots of an inflected language, like Dutch, could be lexically stored, which would logically mean that increasing knowledge of morphosyntax in children should also be associative of their inhibition abilities.

Research Questions

1. Are expressive and receptive measures of lexicon associative of typically-developing monolingual child Spanish-speakers' inhibitory ability?

2. Are expressive and receptive measures of morphosyntax associative of typically-developing monolingual child Spanish-speakers' inhibitory ability?

Methodology

Participants

82 monolingual, typically-developing Spanish-speaking children (age range = 50 – 101 months, mean age = 75.8 months [6 years, three months], SD = 14.7 months) participated in our study. An OSU IRB-approved consent form was signed for each participant in the study.

Procedures

Children were given 5 lexical measures, including the Peabody Picture Vocabulary Test in Spanish (*Test de Vocabulario en Imágenes Peabody* - TVIP, Dunn et al. 1986), Number of Different Words (NDW) from a spontaneous speech sample, NDW from a Frog Story, the *Adivinanzas* ("Riddles") receptive vocabulary subtest of the Batería de Evaluación de Lengua Española (BELE) and the expressive *Definiciones* ("Definitions") subtest of the BELE. For morphosyntax, MLUw was calculated from the spontaneous production and Frog Story samples, and scores from the receptive *Comprensión* ("Comprehension") and *Producción Dirigida* ("Elicited Production") subtests of the BELE. Children were also given the Flanker Task from the EXAMINER Battery (Kramer et al. 2014), which calculates a "Flanker Score", which is a regression coefficient of accuracy by reaction time.

Results

Descriptive Statistics

	TVIP	NDWe	NDWr	Adiv.	Def.	Compren.	Prod. Dir.	MLUwe	MLUwr	Flanker
Mean	67.90	359.12	109.19	16.55	42.52	31.94	41.74	4.75	5.80	5.64
SD	17.15	82.54	20.95	5.49	11.87	5.59	9.15	0.97	0.86	1.66

Table 1 – Means and Standard Deviations of our measures of lexicon, morphosyntax, and inhibition.

In Table 1, the second row gives the mean scores for our entire sample for each one of our ten measures. In the third row, the standard deviation is given. In the following section, the correlational statistics are given.

Inferential Statistics

		Inhibition	**Lexicon**					**Morphosyntax**			
		Flanker	NDWe	NDWr	TVIP	*Adiv*	*Def*	MLUe	MLUr	*Comp*	*Prod*
Inhib	Flanker		.212	.499**	.452**	.453**	.394**	.287**	.357**	.468**	.458**
Lex	NDWe			.485**	.452**	.327**	.400**	.606**	.411**	.396**	.366**
	NDWr				.475**	.389**	.429**	.445**	.627**	.432**	.546**
	TVIP					.643**	.694**	.508**	.461**	.617**	.651**
	Adivinanzas						.516**	.443**	.316**	.499**	.626**
	Definiciones							.511**	.476**	.458**	.557**
MorSyn	MLUe								.482**	.427**	.421**
	MLUr									.341**	.546**
	Comprehensión										.531**
	Produción Dirigida										

Table 2 – Pearson Product Moment Correlations of Inhibitory, Lexical and Morphosyntactic Measures - Note: ** $p < .01$; NDWr= Number of Different Words rana (rana=frog in Spanish); NDWe= Number of Different Words espontáneo (espontáneo=spontaneous in Spanish).

Based on the information present in Table 2, we see that that all lexical variables significantly correlated with inhibition, as measured by the Flanker Task ($p < .01$), except for NDW, calculated from the spontaneous production sample ($r = .212$, $p = .055$). Additionally, we find that all morphosyntactic variables correlated with Flanker ($p < .01$).

Discussion

Returning to our research questions, we first asked whether increasing lexical development was associative of inhibition in child Spanish. Based on the present data, we see that inhibition is indeed predicted by lexical development in child Spanish, both receptively and expressively, measured in both controlled and unstructured fashions. For our second research question, we asked whether increasing morphosyntactic development was associative of inhibition. Again, multiple expressive (MLUe, MLUr, Producción Dirigida) and one receptive measure of morphosyntax (Comprehensión) were associative of children's inhibition scores. The novel findings for morphosyntax, in particular, are consistent with the hypothesis that an ever-increasing set of competitor morphological forms requires an ever-increasing inhibitory ability. This increasing demand from morphosyntax could arise as a result of more closed-class morphemes, including inflectional affixes, being added to the lexicon during development. Alternatively, following Baayen et al. (2002), Culicover & Novak (1999), and others, children could be adding fully-inflected forms, and not just the affixes, to their lexicons. On this view, each of the 47 possible forms of every Spanish verb a child knows could potentially be stored in the lexicon as a morphologically unitary item. Similarly, nouns and adjective carry inflectional morphology that produce competitor forms that may need to be inhibited. This would obviously require greater lexical storage than stem + affix composition of verb forms. Future work should tease these not necessarily mutually exclusive alternatives apart. This project simply shows that

lexicon and morphosyntax may have similar properties with respect to the part of cognition that has to reduce the number of competitors forms that could correspond to linguistic meaning. We speculate from these results that lexical storage of inflectional morphemes would be just as necessary, if not more, of domain-general inhibition in languages with more morphology; more lexical storage and more competitors should mean more need for inhibition. Additionally, we speculate from these results that bilingual children who are on the autism spectrum and bilingual children with attention hyperactive deficit disorder would show a greater need for inhibitory control, yet might be at a greater disadvantage than their peers to be able to successfully control certain impulses.

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